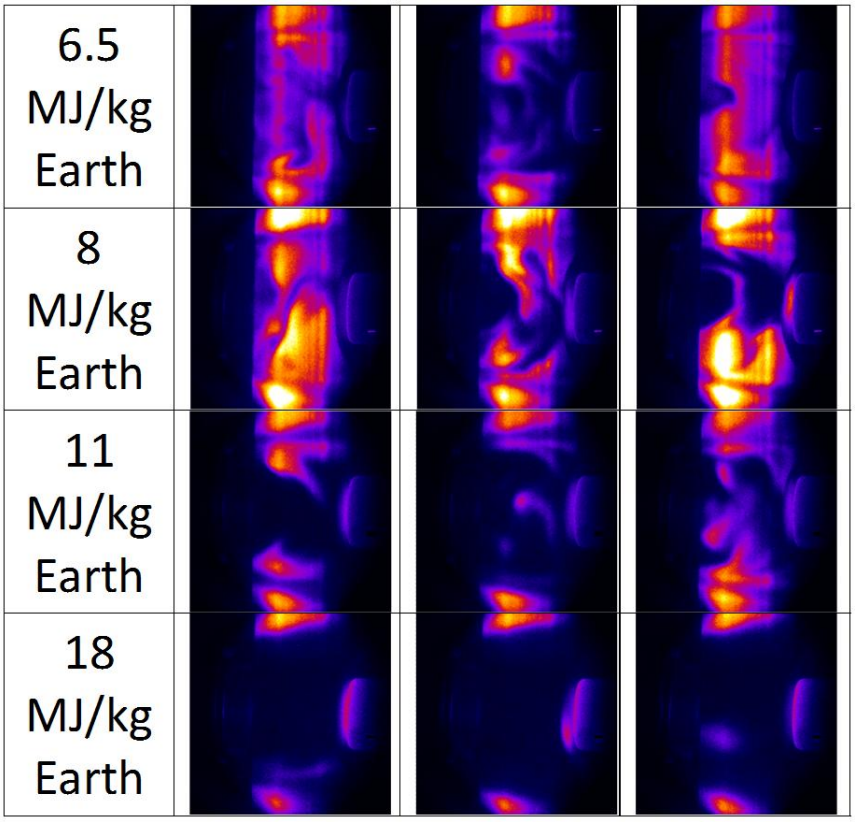
Nitric Oxide PLIF Measurements in the Hypersonic Materials Environmental Test System (HYMETS)

Paul M. Danehy, NASA Langley Research Center, USA

A nonintrusive laser-based measurement system has been applied for the first time in the HYMETS (Hypersonic Materials Environmental Test System) 400 kW arc-heated wind tunnel at NASA Langley Research Center. Planar laser-induced fluorescence of naturally occurring nitric oxide (NO) has been used to obtain instantaneous flow visualization images, and to make both radial and axial velocity measurements. Results are presented at selected facility run conditions, including some in simulated Earth atmosphere (75% nitrogen, 20% oxygen, 5% argon) and others in simulated Martian atmosphere (71% carbon dioxide, 24% nitrogen, 5% argon), for bulk enthalpies ranging from 6.5 MJ/kg to 18.4 MJ/kg. Flow visualization images reveal the presence of large scale unsteady flow structures, and indicate nitric oxide fluorescence signal over more than 70% of the core flow for bulk enthalpies below about 11 MJ/kg, but over less than 10% of the core flow for bulk enthalpies above about 16 MJ/kg. Axial velocimetry was performed using molecular tagging velocimetry (MTV). Axial velocities of about 3 km/s were measured along the centerline. Radial velocimetry was performed by scanning the wavelength of the narrowband laser and analyzing the resulting Doppler shift. Radial velocities of ±0.5 km/s were measured.



Typical PLIF images of naturally occurring nitric oxide present in the freestream of the HYMETS facility. Flow is from left to right. Three single shot images are shown for each of four different flow enthalpies.

The images indicate that the flow is nonuniform in the freestream, and that the nitric oxide concentration decreases at enthalpy increases.